

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application. Please amend claims 1, 6-8, 13, 18-20, and 25-30 of the original patent claims. Please cancel claims 4, 5, 10, 16-17, and 22 of the original patent claims. Please cancel claims 31-76. Please add new claims 77-117.

Listing of Claims:

1. (Once Amended) A pad refurbisher for in situ, real-time refurbishing of a polishing surface on a polishing pad used in chemical-mechanical polishing of a semiconductor wafer, comprising:

a body adapted for attachment to a wafer carrier of a chemical-mechanical polishing machine with the body having a first ring and a second ring each with a face positioned proximate to a perimeter portion of the wafer carrier and facing the polishing surface of the polishing pad, the body being adapted to travel with the wafer carrier as the wafer carrier moves over the polishing pad; and

a first refurbishment element connected to the face of the first ring and a second refurbishment element connected to the face of the second ring[a refurbishing element connected to the face of the body], the first ring operably coupled to a first linear actuator configured to independently move the first ring downwardly to selectively engage the first refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the second ring to selectively disengage the first refurbishment element from the polishing surface and the second ring operably coupled to a second linear actuator configured to independently move the second ring downwardly to selectively engage the second refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the first ring to selectively disengage the second refurbishment element from the polishing surface, the first ring being positioned radially outward from the perimeter of the wafer carrier and the second ring being positioned radially outward from the first ring, the first and the second refurbishing [element]elements being adapted to engage the polishing surface substantially adjacent to the perimeter portion of the wafer carrier and traveling with the wafer carrier while the wafer carrier moves the wafer over the polishing surface.

6. (Once Amended) The pad refurbisher of claim 1 wherein [the body has]the first ring and the second ring each include a plurality of arcuate segments positioned radially outwardly from the perimeter of the wafer carrier, the arcuate segments being spaced apart from one another around the wafer carrier and each arcuate segment having a distal face facing generally towards the polishing surface of the polishing pad.

7. (Once Amended) The pad refurbisher of claim 1 wherein one of the refurbishing [element] elements is a brush comprising a plurality of bristles extending downwardly from the face towards the polishing surface, the bristles engaging the polishing surface to clean waste particles from the pad.

8. (Once Amended) The pad refurbisher of claim 1 wherein one of the refurbishing [element] elements is a pad conditioner that removes a layer of pad material from polishing surface of the pad to form a new polishing surface on the polishing pad.

13. (Once Amended) A polishing machine for chemical-mechanical polishing of a semiconductor wafer, comprising:

a platen having an upper surface;

a polishing pad positioned on the upper surface of the platen, the polishing pad having a polishing surface facing away from the platen;

a wafer carrier for carrying the wafer, the wafer carrier being positioned over the polishing pad and moveable along an axis substantially normal to the upper surface of the platen to engage the wafer with the polishing pad, wherein at least one of the platen and the wafer carrier moves with respect to the other to impart relative motion between the wafer and the polishing pad; and

a pad refurbisher having a body including a first ring and a second ring each with a face positioned proximate to a perimeter portion of the wafer carrier and facing generally towards the polishing surface [and a refurbishing element connected to the face], the first ring having a first refurbishment element connected to the face thereof, the first ring operably coupled to a first linear actuator configured to independently move the first ring downwardly to

selectively engage the first refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the second ring to selectively disengage the first refurbishment element from the polishing surface and the second ring having a second refurbishment element connected to the face thereof, the second ring operably coupled to a second linear actuator configured to independently move the second ring downwardly to selectively engage the second refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the first ring to selectively disengage the second refurbishment element from the polishing surface, the first ring being positioned radially outward from the perimeter of the wafer carrier and the second ring being positioned radially outward from the first ring, the body being attached to the wafer carrier so that the body and the first and the second refurbishing [element] elements travel with the wafer carrier as the wafer carrier moves with respect to the polishing pad, wherein the first refurbishing element engages the polishing surface substantially adjacent to the perimeter portion of the wafer carrier while the wafer carrier moves the wafer over the polishing surface.

18. (Once Amended) The polishing machine of claim 13 wherein [the body has] the first ring and the second ring each include a plurality of arcuate segments positioned radially outwardly from the perimeter of the wafer carrier, the arcuate segments being spaced apart from one another around the wafer carrier and each arcuate segment having a distal face facing generally towards the polishing surface of the polishing pad.

19. (Once Amended) The polishing machine of claim 13 wherein one of the refurbishing [element] elements is a brush comprising a plurality of bristles extending downwardly from the face towards the polishing surface, the bristles engaging the polishing surface to clean waste particles from the pad.

20. (Once Amended) The polishing machine of claim 13 wherein one of the refurbishing [element] elements is a pad conditioner that removes a layer of pad material from polishing surface of the pad to form a new polishing surface on the polishing pad.

25. (Once Amended) A method for refurbishing a polishing pad, comprising the steps of:

providing a pad refurbisher having a body including a first ring and a second ring each with a face positioned proximate to a perimeter portion of a wafer carrier of a chemical-mechanical polishing machine and facing generally towards the polishing surface, and a first refurbishing element connected to the face of the first ring and a second refurbishment element connected to the face of the second ring [body], the body being attached to the wafer carrier;

selectively engaging [the pad]one of the first and the second refurbishing [element] elements with the polishing pad; and

moving at least one of the wafer carrier and the polishing pad with respect to the other to pass at least one of the refurbishing [element]elements across the polishing pad.

26. (Once Amended) The method of claim 25 wherein the selectively engaging step comprises selectively lowering the body towards the polishing pad while the wafer carrier presses a wafer against the polishing pad and moves the wafer over the polishing pad to polish the wafer.

27. (Once Amended) The method of claim 26 wherein the method further comprises selectively disengaging one of the refurbishing [element]elements from the polishing pad.

28. (Once Amended) The method of claim 25 wherein the engaging step comprises lowering the wafer carrier until one of the refurbishing [element]elements and a wafer abut the polishing pad.

29. (Once Amended) The method of claim 25 wherein the first refurbishing element comprises a pad conditioner and the second refurbishment element comprises a pad cleaner, and wherein the engaging step comprises pressing the pad conditioner and the pad cleaner against the polishing pad.

30. (Once Amended) The method of claim 26 wherein one of the refurbishing [element]elements is selectively engaged with deteriorated portions of the polishing pad with accumulations of waste matter.

77. A pad refurbisher for refurbishing a polishing surface on a polishing pad used in chemical-mechanical polishing of a semiconductor wafer, comprising:

a body adapted for attachment to a wafer carrier of a chemical-mechanical polishing machine with the body having a first ring and a second ring each with a face positioned proximate to a perimeter portion of the wafer carrier and facing the polishing surface of the polishing pad; and

a first refurbishment element connected to the face of the first ring and a second refurbishment element connected to the face of the second ring, the first ring operably coupled to a first linear actuator configured to independently move the first ring downwardly to selectively engage the first refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the second ring to selectively disengage the first refurbishment element from the polishing surface and the second ring operably coupled to a second linear actuator configured to independently move the second ring downwardly to selectively engage the second refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the first ring to selectively disengage the second refurbishment element from the polishing surface, the first ring being positioned radially outward from the perimeter of the wafer carrier and the second ring being positioned radially outward from the first ring, the first and the second refurbishing elements being adapted to engage the polishing surface substantially adjacent to the perimeter portion of the wafer carrier.

78. The pad refurbisher of claim 77 wherein the body is fixed to the wafer carrier.

79. The pad refurbisher of claim 77 wherein the body is slidably attached to the wafer carrier.

80. The pad refurbisher of claim 77 wherein the face is a distal face of the body defining a ring positioned radially outwardly from the perimeter of the wafer carrier.

81. The pad refurbisher of claim 77 wherein the first ring and the second ring include a plurality of arcuate segments positioned radially outwardly from the perimeter of the wafer carrier, the arcuate segments being spaced apart from one another around the wafer carrier and each arcuate segment having a distal face facing generally towards the polishing surface of the polishing pad.

82. The pad refurbisher of claim 77 wherein one of the refurbishing elements is a brush comprising a plurality of bristles extending downwardly from the face towards the polishing surface, the bristles engaging the polishing surface to clean waste particles from the pad.

83. The pad refurbisher of claim 77 wherein one of the refurbishing elements is a pad conditioner that removes a layer of pad material from polishing surface of the pad to form a new polishing surface on the polishing pad.

84. The pad refurbisher of claim 83 wherein the pad conditioner comprises a pad with a plurality of embedded diamonds, the pad being connected to the distal surface of the body.

85. The pad refurbisher of claim 77 wherein the first refurbishing element is a pad cleaner and the second refurbishing element is a pad conditioner.

86. The pad refurbisher of claim 77 wherein the body is adapted to be symmetrically positioned about the center of the wafer carrier.

87. A polishing machine for chemical-mechanical polishing of a semiconductor wafer, comprising:

a platen having an upper surface;

a polishing pad positioned on the upper surface of the platen, the polishing pad having a polishing surface facing away from the platen;

a wafer carrier for carrying the wafer; and

a pad refurbisher having a body attached to the wafer carrier, the body including a first ring having a first refurbishment element and a second ring having a second refurbishment element, the first ring operably coupled to a first linear actuator configured to independently move the first ring downwardly to selectively engage the first refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the second ring to selectively disengage the first refurbishment element from the polishing surface and the second ring operably coupled to a second linear actuator configured to independently move the second ring downwardly to selectively engage the second refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the first ring to selectively disengage the second refurbishment element from the polishing surface, the first ring being positioned radially outward from the perimeter of the wafer carrier and the second ring being positioned radially outward from the first ring.

88. The polishing machine of claim 87 wherein the first and the second ring each comprise a face positioned proximate to a perimeter portion of the wafer carrier and facing generally towards the polishing surface.

89. The polishing machine of claim 88 wherein the first refurbishing element is connected to the face of the first ring and the second refurbishment element is connected to the face of the second ring, and wherein the body being attached to the wafer carrier so that the body and each of the refurbishing elements travel with the wafer carrier as the wafer carrier moves with respect to the polishing pad, and wherein each of the refurbishing elements engages the polishing surface substantially adjacent to the perimeter portion of the wafer carrier while the wafer carrier moves the wafer over the polishing surface.

90. The polishing machine of claim 87 wherein the body is fixed to the wafer carrier.

91. A method for refurbishing a polishing pad, comprising the steps of:  
providing a pad refurbisher attached to a wafer carrier, the pad refurbisher having  
a first ring bearing a first refurbishment element and a second ring bearing a second  
refurbishment element;

selectively engaging one of the first and the second refurbishing elements with the  
polishing pad; and

moving at least one of the wafer carrier and the polishing pad with respect to the  
other to pass at least one of the refurbishing elements across the polishing pad.

92. The method of claim 91 wherein selectively engaging comprises  
selectively lowering at least one of the refurbishing elements towards the polishing pad while the  
wafer carrier presses a wafer against the polishing pad and moves the wafer over the polishing  
pad to polish the wafer.

93. The method of claim 91 further comprising selectively disengaging the  
one of refurbishing elements from the polishing pad.

94. The method of claim 93 wherein one of the refurbishing elements is  
selectively disengaged from relatively unused portions of the polishing pad not having  
accumulations of waste matter.

95. The method of claim 91 wherein the selectively engaging comprises  
lowering the wafer carrier until one of the refurbishing elements and a wafer abut the polishing  
pad.

96. The method of claim 91 wherein one of the refurbishing elements is  
selectively engaged with deteriorated portions of the polishing pad with accumulations of waste  
matter.



97. The method of claim 91 wherein one of the refurbishing elements is selectively engaged and disengaged from the polishing pad as a function of the use of portions of the pad.

98. A pad refurbisher for refurbishing a polishing surface on a polishing pad used in chemical-mechanical polishing of a semiconductor wafer, comprising:

a body adapted for attachment to a wafer carrier of a chemical-mechanical polishing machine with the body having a first ring and a second ring each with a face positioned proximate to a perimeter portion of the wafer carrier and facing the polishing surface of the polishing pad, the body being moveably attached to the wafer carrier; and

a first refurbishment element connected to the face of the first ring and a second refurbishment element connected to the face of the second ring, the first ring operably coupled to a first linear actuator configured to independently move the first ring downwardly to selectively engage the first refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the second ring to selectively disengage the first refurbishment element from the polishing surface and the second ring operably coupled to a second linear actuator configured to independently move the second ring downwardly to selectively engage the second refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the first ring to selectively disengage the second refurbishment element from the polishing surface, the first ring being positioned radially outward from the perimeter of the wafer carrier and the second ring being positioned radially outward from the first ring, the first and the second refurbishing elements being adapted to engage the polishing surface substantially adjacent to the perimeter portion of the wafer carrier.

99. The pad refurbisher of claim 98 wherein the body is fixed to the wafer carrier.

100. The pad refurbisher of claim 98 wherein the body is slidably attached to the wafer carrier.

101. The pad refurbisher of claim 98 wherein the first ring and the second ring include a plurality of arcuate segments positioned radially outwardly from the perimeter of the wafer carrier, the arcuate segments being spaced apart from one another around the wafer carrier and each arcuate segment having a distal face facing generally towards the polishing surface of the polishing pad.

102. The pad refurbisher of claim 98 wherein one of the refurbishing elements is a brush comprising a plurality of bristles extending downwardly from the face towards the polishing surface, the bristles engaging the polishing surface to clean waste particles from the pad.

103. The pad refurbisher of claim 98 wherein one of the refurbishing elements is a pad conditioner that removes a layer of pad material from polishing surface of the pad to form a new polishing surface on the polishing pad.

104. The pad refurbisher of claim 103 wherein the pad conditioner comprises a pad with a plurality of embedded diamonds, the pad being connected to the distal surface of the body.

105. The pad refurbisher of claim 98 wherein the first refurbishing element is a pad cleaner and the second refurbishing element is a pad conditioner.

106. The pad refurbisher of claim 98 wherein the body is adapted to be symmetrically positioned about the center of the wafer carrier.

107. A polishing machine for chemical-mechanical polishing of a semiconductor wafer, comprising:

a platen having an upper surface;

a polishing pad positioned on the upper surface of the platen, the polishing pad having a polishing surface facing away from the platen;

a wafer carrier for carrying the wafer; and

a pad refurbisher having a body including a first ring bearing a first refurbishment element and a second ring bearing a second refurbishment element, the body being movably attached to the wafer carrier, the first ring operably coupled to a first linear actuator configured to independently move the first ring downwardly to selectively engage the first refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and second ring to selectively disengage the first refurbishment element from the polishing surface and the second ring operably coupled to a second linear actuator configured to independently move the second ring downwardly to selectively engage the second refurbishment element with the polishing surface and upwardly with respect to the wafer carrier and the first ring to selectively disengage the second refurbishment element from the polishing surface, the first ring being positioned radially outward from the perimeter of the wafer carrier and the second ring being positioned radially outward from the first ring.

108. The polishing machine of claim 107 wherein the first ring comprises a face positioned proximate to a perimeter portion of the wafer carrier and facing generally towards the polishing surface.

109. The polishing machine of claim 108 wherein the first refurbishing element is connected to the face, and wherein the body being movably attached to the wafer carrier so that the body and the first and the second refurbishing [element]elements travel with the wafer carrier as the wafer carrier moves with respect to the polishing pad, and wherein at least one of the refurbishing elements engages the polishing surface substantially adjacent to the perimeter portion of the wafer carrier while the wafer carrier moves the wafer over the polishing surface.

110. The polishing machine of claim 107 wherein the body is fixed to the wafer carrier.

111. A method for refurbishing a polishing pad, comprising the steps of:  
providing a pad refurbisher attached to a wafer carrier, the pad refurbisher having a body including a first ring bearing a first refurbishment element and a second ring bearing a second refurbishment element, the body being movably attached to the wafer carrier;

selectively engaging one of the first and the second refurbishing elements with the polishing pad; and

moving at least one of the wafer carrier and the polishing pad with respect to the other to pass at least one of the refurbishing elements across the polishing pad.

112. The method of claim 111 wherein selectively engaging comprises selectively lowering at least one of the refurbishing elements towards the polishing pad while the wafer carrier presses a wafer against the polishing pad and moves the wafer over the polishing pad to polish the wafer.

113. The method of claim 111 further comprising selectively disengaging at least one of the refurbishing elements from the pad.

114. The method of claim 113 wherein the at least one of the refurbishing elements is selectively disengaged from relatively unused portions of the polishing pad not having accumulations of waste matter.

115. The method of claim 111 wherein the selectively engaging comprises lowering the wafer carrier until one of the refurbishing elements and a wafer abut the polishing pad.

116. The method of claim 111 wherein one of the refurbishing elements is selectively engaged with deteriorated portions of the polishing pad with accumulations of waste matter.

117. The method of claim 111 wherein one of the refurbishing elements is selectively engaged and disengaged from the polishing pad as a function of the use of portions of the pad.